Abbingdon Music Research

LS-77 Reference Class

Professional Monitor Loudspeakers

Owner's Manual

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WARNINGS

The exclamation point within an equilateral triangle is intended to alert the user to the presence of important operating and maintenance (servicing) instructions in the literature accompanying this component.

This component weighs over 30 kilograms. Do not place this component on an unstable cart, stand, tripod, bracket or table as the component may fall causing serious injury to a child or adult and serious damage to the unit. An appliance and cart combination should be moved with care. Quick stops, excessive force and uneven surfaces may cause the component and cart combination to overturn.

Any mounting of the device on a wall or ceiling should follow the manufacturer's instructions and should use a mounting accessory recommended by the manufacturer.

Read and follow all the safety and operating instructions before connecting or using this component.

All warnings on the component and in its operating instructions should be adhered to.

Retain this Owner's Manual for future reference.

Do not use this unit near water; for example, near a bath tub, washbowl, kitchen sink, laundry tub, in a wet basement or near a swimming pool.

Unplug the component before cleaning. Never use benzine, thinner or other solvents for cleaning; use only a soft damp cloth.

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Precautions

This component has been tested and found to comply with the limits set out in the EMC Directive using a connection cable shorter than 3 metres.

Running-In

AMR estimates that the LS-77 may take between 300-500 operating hoursat fairly high sound pressure levels for all of the internal components to be fully-broken in. Hence, please anticipate the sonic performance of the LS-77 to settle only after it has been used for this approximate length of time.

We recommend the following procedure to speed upthe "burn in" for the LS-77:

Place the speakers face to face with faceplates almost touching and connect normally to the Amplifier. In conjunction with an out of phase mono signal this will cancel most noise. A heavy blanket may be thrown over the speakers to cancel more noise.

Play the “Pink Noise Out Of Phase” track (Track 4) from AMR’s System Test CD (included with the speakers) on repeat. Raise the volume as high as sensible (but quite high), the out of phase nature will cancel a lot of noise, so be careful when raising levels not to overload the Amplifier.

Using AMR’s AM-77 & CD-77 the maximum level recommended for burn in is -10db, the minimum level -16db. When using -16db a minimum of 120 Hours burn in should be applied, with -12…-10db level setting on the AM-77 this can be shortened to 72 Hours. This will take the LS-77’s through the phase where the performance changes quite dramatically.

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Figure 1.1 - Front Panel of the LS-77

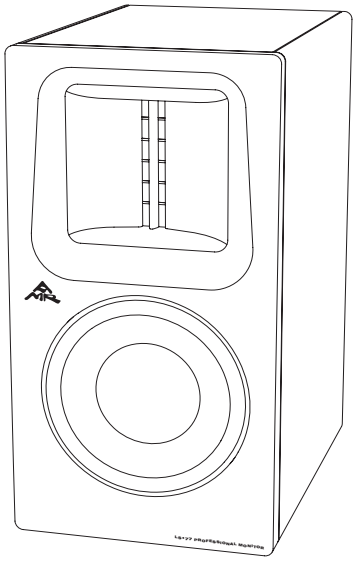
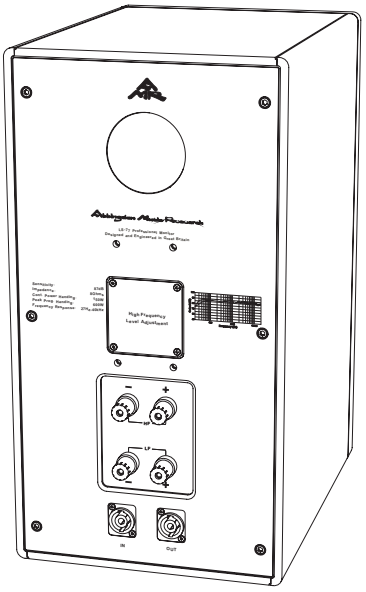


Figure 1.2 - Rear Panel of the LS-77



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Thank you for purchasing this AMR reference class component.

We hope you derive as much pleasure from using your new AMR LS-77 Reference Class Professional Monitors as we have enjoyed making them for you.

Please check that all contents are present

This section refers to the unpacking of the LS-77 and its subsequent setup. Due to the weight the LS-77 Pair is shipped individually packaged.

Upon unpacking, please find in each package:

i. LS-77 Reference Class Professional Monitor
ii. Set of two TO-220 Power Resistors (10R & 22R).
iii. Set of two Foam Port Plugs
iv. Set of two **OptiLink**® *Bi-Wire Jumpers (installed)*
v. Quick-Start Card
vi. AMR Warranty Card
vii. Aluminium professional flightcase
viii. LS-77 Owner's Manual
ix. AMR Test Disk
x. 2mm Allen Key

Please ensure that all items are present. Should an item be missing, please contact your AMR distributor/retailer.

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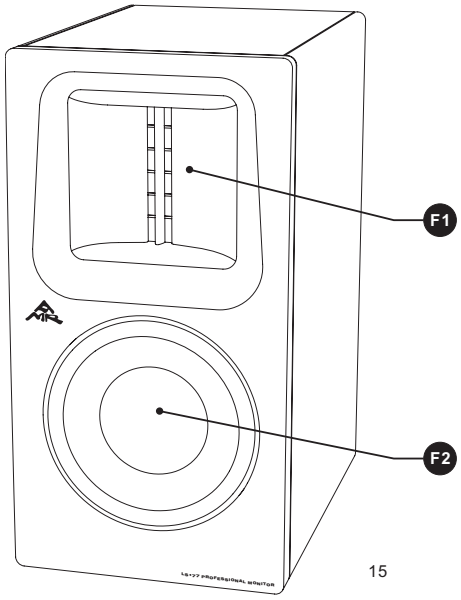
Figure 2.1 - LS-77 Front Fascia



F1. HIGH FREQUENCY driver: to repoduce the high frequencies.

F2. LOW FREQUENCY driver: to reproduce the low frequencies.

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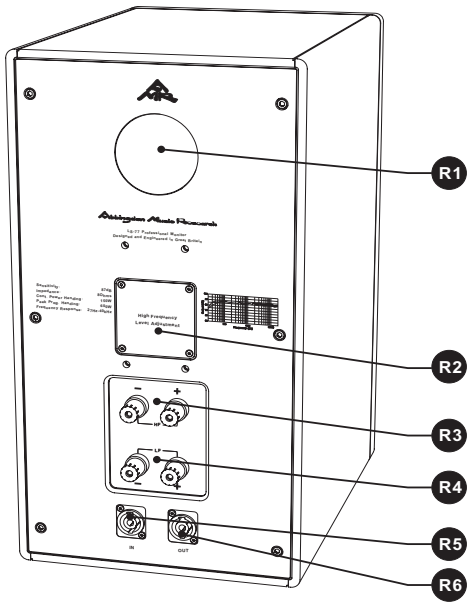
Figure 2.2 - LS-77 Rear Panel



***Warning**:*

ensure no speaker connector is in contact with the chassis

R1. TRANSMISSIONLINE PORT: to reproduce the lowest frequencies.

R2. HIGH FREQUENCY LEVEL ADJUSTMENT cover: to cover the replaceable resistors in the high frequency level adjustment circuit.

R3. SPADE/BANANA high frequency inputs: for connection of standard termination speaker cables.

R4. SPADE/BANANA low frequency inputs: for connection of standard termination speaker cables.

R5. SPEAKON® low & high frequency outputs: for connection of Speakon terminated speaker cables.

R6. SPEAKON® low & high frequency inputs: for connection of Speakon terminated speaker cables.

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3.1 Connecting the loudspeakers

AMR recommends the sonically superior Speakon connectors

The LS-77 is fitted with shrouded binding posts prepared for bi-wiring that are standard in high end audio. However, we do not normally recommended their use. They are provided to allow users to easily integrate our speakers into an existing system already fitted with cables prepared for such connections.

AMR's preferred connection method is the professional Neutrik Speakon connector. This provides a sonically vastly superior and more reliable method of connection, due to the connector's gold contacts, gastight construction and special locking, high-pressure contact arrangement.

AMR's own speaker cables are equipped with Speakon connectors, as are AMR's amplifiers thus guaranteeing the highest performance and most reliable method of speaker connection available.

3.1.1 Using AMR's OptiLink Speakon® Cable

When using AMR's Speakon® equipped OptiLink loudspeaker cables, you simply plug the Speakon® connector into the Speakon® socket marked "IN" and then twist the whole connector clockwise to lock the connector. This establishes a full bi-wired connection with the correct polarity and ensures the connection is maximally tight and corrosion free all in one go.

To disconnect the Speakon® cable you need to pull back the latch and twist the connector counterclockwise. Then you can simply pull out the plug.

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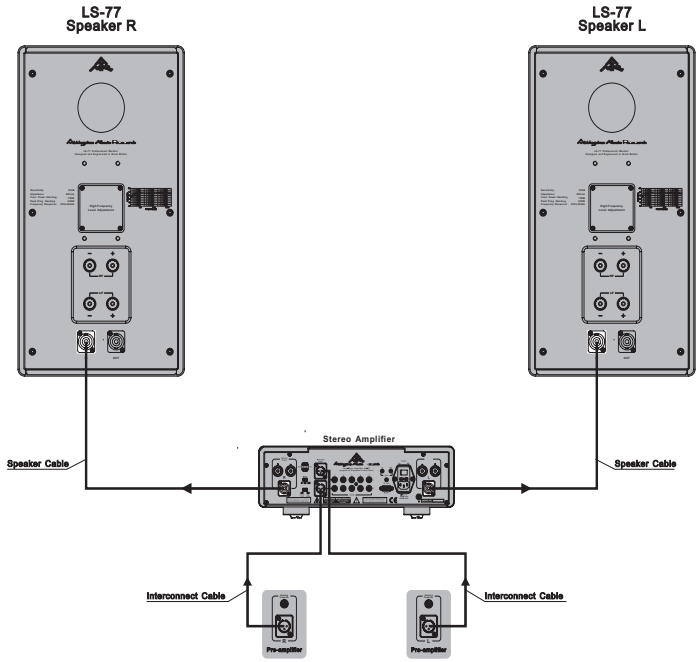

Figure 3.1 - System connection using Speakon connector equipped speaker cables

i. Connect the respective Speakon® connectors of the speaker cables to the LS-77 (left & right).

ii. Connect the respective Speakon® connectors of the speaker cables to your amplifier.

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3.1.2 Using Binding Posts

When not using AMR's or another manufacturer's Speakon® equipped loudspeaker cables, you need to use a conventional two or four pole speaker cable. Please consult your authorised AMR retailer for recommendations.

Connect a suitable loudspeaker cable to the speaker binding posts, located at rear of the LS-77.

When using two-pole speaker cables, the cable should be connected to the upper pair of binding posts and the included short Bi-Wire Jumper Cables must be connected between the upper and lower binding post of the same colour marking. When using four-pole speaker cables usually two of these poles will be dedicated to carrying the high frequency signal, connect these to the upper pair of binding posts. The low frequency poles are connected to the lower binding posts. In all cases observe the polarity, usually marked by black and red markers on the cable and match these markers with the colour coding of the binding posts.

The LS-77 high quality binding posts can accommodate different connection systems:

6 mm pins: The pins can be placed directly into the binding post without any screwing necessary.

Cable spades: Un-tighten the binding posts, insert the spades into the openings, and secure the spades into the posts by tightening the posts. Tighten the posts, and check the contacts after a few days to make sure that they have not loosened.

Bare wires: Un-tighten the binding posts and place the cable into the binding posts. Tighten the posts. With bare wire terminations, make sure that no thin metal strand of wire is in contact with another strand of wire. Tighten the posts, and check the contacts after a few days to make sure that they have not loosened.

Warning: ensure no speaker connector is in contact with the speaker enclosure to cause a short-circuit!

With every connection system, it is important to ensure that the contact is tight and has a proper contact area. Connectors with similar gold plating as the LS-77 Reference Class Professional Monitor binding posts will typically offer the best results while also remaining corrosion-free.

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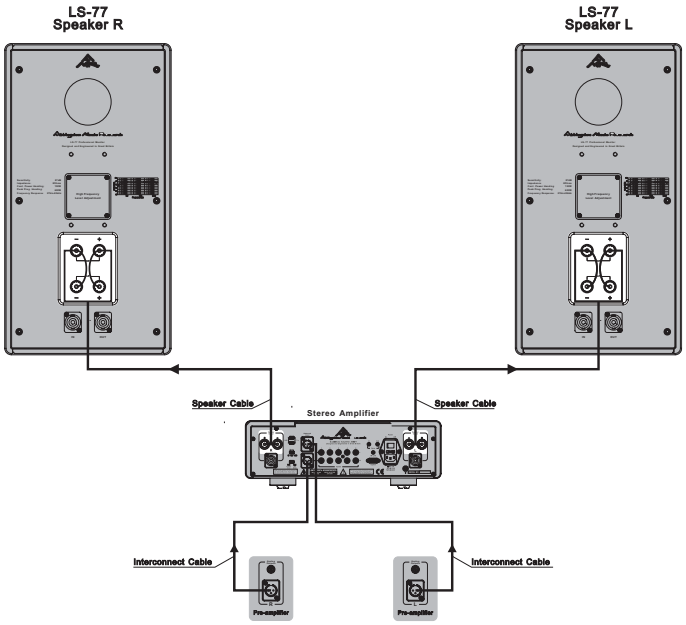

Figure 3.2 - System connection using banana plug/spade connector equipped speaker cables

i. Connect the respective bi-wire jumper cables as shown.

ii. Connect the respective spade/banana connector or bare wire of the speaker cables to the LS-77.

iii. Connect the respective spade/banana connector or bare wire of the speaker cables to your amplifier.

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3.2. Connecting the amplifier

Always switch your amplifier off when making or breaking connections.

Connect the other cable ends to the loudspeaker outputs of your switched-off power amplifier. When using Speakon® equipped speaker cables you only need to identify the correct channel and connect the cable. If using two or four pole speaker cables of conventional design, please make sure that the red marked posts of the speaker are connected to the red marked output of your amp, and the white or black marked posts to the white or black marked output accordingly.

AMR loudspeakers feature a carefully matched and fine-tuned crossover, to achieve a truly balanced and smooth frequency response. However, optimising the frequency bands through bi-wiring or bi-amplification can offer significant benefits. Please consult your authorised AMR retailer for recommendations and demonstrations and see the Appendix C - Biamplifying the LS-77 for options using AMR equipment.

3.3 Multi-channel set up

The AMR LS-77 Reference Class Professional Monitor is designed to offer the most advanced performance in both stereo and multi-channel applications, effectively enabling the maximum performance from either of these formats. When connecting a loudspeaker to a multi-channel system, in general the same guidelines as previously mentioned in the text above will apply. Because there are many different set up options - from 5.1 to 10.2 channel applications - and due to the fact that loudspeaker positioning will also depend upon the room's particular shape, please consult your authorised AMR retailer for special applications and placement options.

3.4 Choice of loudspeaker cable

The loudspeaker cable may may have a dramatic effect on sound quality, though in general, quality cable products will yield a quality result. The LS-77's are designed to be very neutral, and as such are not extremely reliant on any one particular type of cable. The choice of cable is as much a factor of matching the cable to the entire audio system, while also a matter of personal taste and preference. In an all AMR System AMR's OptiLink Speakon® connector equipped cables are highly recommended.

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Section 4 - Positioning

The LS-77 Reference Class Professional Monitor is a Transmissionline port loaded loudspeaker design with no unusual or extraordinary positioning demands, neither in stereo nor in multichannel applications. Despite this, every room will typically have its own particular sound characteristics as shaped by its own acoustic properties. Rooms are also shaped, decorated and furnished uniquely, and therefore remain quite independent regarding options for positioning loudspeakers. AMR suggests that you consult your experienced AMR retailer for further assistance if needed. The following steps are general suggestions that will optimise the speaker placement.

4.1 Symmetry and room modes

Always try to place the speakers symmetrical in the listening room.

It is preferred to establish a loudspeaker layout that provides an adequate and equal left/right image. The basis for this symmetry, meaning that the distance from the listening position to the left and the right speakers should be identical; and if not listening in the near field (1m or less), then additionally identical distance to the side-walls should be maintained.

In all normal rooms certain low frequencies will be boosted or reduced by standing waves developing between parallel walls. If the speakers are placed directly at walls or at half way or quarter way between walls these standing waves will influence the speakers' performance to the largest extent, hence such placement is best avoided. Equally, it is preferable to locate the listener not at any half way or quarter way point between parallel walls. You may also wish to review the material in Appendix F - Acoustics Background Information for more details.

4.2 Distance between the loudspeakers

AMR recommends a distance between the speakers from slightly less (closer together) to slightly wider (further apart) than the distance from the point centered in-between the pair of speakers and the listening position.

The closer the listening position is in relation to the loudspeakers, the closer the speakers need to be positioned to each other, though as a starting point it is recommended that the speakers be about 2.0 - 3.0 meters apart from each other.

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If the speakers are positioned too close to each other, the stereo image will not seem realistic; if that distance is too wide, the image may leave an acoustic hole in the middle. Paying attention to the image during listening tests and using the adjustment/diagnostic tracks on AMR's test CD will help dictate optimum placement during experimentation and set-up. A distance between the loudspeakers that is approximately the same as the distance to the listening position is a good starting point for such experimentation during set-up.

4.3 Distance to the loudspeakers

Because of the excellent integration of frequencies, the LS-77 Reference Class Professional Monitors will deliver excellent imaging even in near-field applications with small listening distances. The distance to the speakers ultimately depends upon the room's shape, size and your personal listening taste. Please note that when listening to the speakers from a long distance, the room must allow the speakers to be positioned with a wider distance between each other as well.

To maintain a balanced sound integration from the driver arrangement, a 2.0 meter distance is a good starting point during experimentation. The listening distance to each speaker from the listening position should be identical.

4.4 Distance to back and side walls

When loudspeakers are positioned too close to walls, the sound quality can be restricted. Time-delayed reflections occur and add colorations, distorting the original music signal. The LS-77 Reference Class Professional Monitor was developed to be primarily placed free-standing, and therefore reaches its optimum performance when positioned as clear of any walls as possible. The rear bass port was tuned to integrate perfectly with the drivers, thus if possible, this port should not be covered by any surfaces or objects. However, the loudspeakers may effectively be placed into cabinets or enclosures as long as there is a minimal (one-inch) clearance above and behind the speakers. When placing the Speaker very close to walls it may be necessary to adjust both the high frequency and low frequency balance of the speakers (see Appendix A - Adjustment of tonal balance).

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4.5 Levelling/Speaker Support

The best surface for any compact speaker is a dedicated stand construction, providing a solid foundation and allowing the proper listening height (high frequency driver at ear height). Dedicated high quality stands are available at your AMR retailer.

As an alternative, the LS-77 may also be placed on shelves, bases or furniture.

This will often restrict the sound quality, though with careful use of some basic techniques and due to the wide ranging adjustability of AMR's speakers it is possible to materially minimise any negative influence.

Always place the speakers on a rigid and level surface!

a) Set the speaker on a solid, rigid level surface using compliant supports (available from your AMR retailer). The surface should be free from resonances. There must me no protrusions or other obstructions in front of the speakers.

b) Place the speakers so that the high frequency drivers are at ear-height and oriented vertically.

c) If necessary the speakers can be placed with the woofer above the tweeter to make this easier to achieve.

d) If necessary the high frequency drivers can be rotated by 90 Degrees. This will be carried by your authorised AMR retailer as it requires disassembly of your speakers.

e) If the speakers cannot be placed with the high frequency drivers at ear-height use placement that elevates the high frequency drivers as close as possible to ear-height. Then use suitable means to elevate either the rear or front edge of the speaker to aim the high frequency drivers main axis at approximately ear height at the listening position.

f) If necessary, adjust both the high frequency and low frequency balance of the speakers (see Appendix A - Adjustment of tonal balance).

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4.6 Loudspeaker Toe-in

Toe-in of the speakers often improves imaging!

Depending on your personal listening environment and room dimensions, the LS-77 Reference Class Professional Monitors may be angled in towards the listening area to help focus the sound radiation. This positioning will typically improve imaging, and is recommended by AMR. The ultimate positioning, however, is also a matter of personal taste and room acoustics.

4.7 Room and furniture influence

The furniture, wall materials and other objects found in the listening room may influence the sound quality of any loudspeaker. Therefore it may be necessary to adjust both the high frequency and low frequency balance of the speakers (see Appendix A - Adjustment of tonal balance) to suit your listening environment.

Furniture and general room design strongly influence the sonic result!

For example, a large room without much furniture that has many clean, hard wall surfaces may yield a bright and diffuse sound with diverse reverberating frequencies. In such a case, due to the "Controlled Dispersion" design of the LS-77, a placement with as much toe-in as is practical can reduce the reverb significantly. By adjusting the high frequency tonal balance to produce less high frequency output the bright tonal balance may be ameliorated. Nevertheless, it may also be desirable to fit some acoustic treatment or at least some carpets and maybe some heavy wall-hanging rugs or whatever means are suitable to domestic harmony.

A room with thick carpet, curtains and many soft furniture surfaces might yield a slightly warmer, darker and less lively sound. In such a case using very little toe-in and adjusting the high frequency tonal balance to produce more high frequency output can produce a more lively and open sound.

Please consult your authorised AMR retailer for recommendations and help. In order to maximise the sonic quality of the reproduction from your LS-77 speakers you may also wish to employ the Abbingdon Acoustic Setup Regime (AASR) described in the Appendix B.

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5.1 Care and maintenance

To maintain the aesthetic quality of the LS-77 Reference Class Professional Monitors for the long term, placing them into a very warm, very cold, or very humid environment should be avoided. Direct sunlight or excessive brightness can affect the drivers but will have no effect on the Aluminum Enclosure..

Never use aggresive or abrasive cleaners!

The cabinet and other plain parts should be cleaned with a soft dry or slightly damp cloth. Please avoid any aggressive cleaning fluids or abrasive cleaners. Dust on the woofer diaphragms or the tweeters waveguide may be removed with a fine furniture brush.

For safety reasons, please switch off all the components of your system when cleaning any of these components. As any form of cloth or foam cover or metal grille interferes significantly with sound reproduction, no grill is included.

All materials used by AMR are integrated into the LS-77 Reference Class Professional Monitors with exceptional care. By taking care of your LS-77 Reference Class Professional Monitors, you will preserve the finish and build quality for a very long time.

5.2 Running-in the loudspeakers

The moving parts of a newly manufactured LS-77 Reference Class Professional Monitors have been acoustically checked after production, but nevertheless are not as flexible as they need to be for optimum performance results to be realised. The higher the quality of any driver system, the more demanding the loudspeaker will be regarding time for running-in the system. A newly unpacked pair of AMR speakers therefore requires several weeks of running in or playing to reach its optimum performance capability. After that period, a couple of minutes before every listening session will be helpful to ‘warm up’ the loudspeakers.

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5.3 Power rating

Due to the construction and the driver technology, the LS-77 Reference Class Professional Monitors can be driven with very high power levels. With a high quality amplifier, delivering undistorted signals, the LS-77 can achieve high volumes without any compromise in sound quality. Also, as the LS-77 Reference Class Professional Monitors have a reasonably high sensitivity, even high quality amps with a medium power rating can drive the speaker to yield excellent results.

Attention must be given to amplifiers with very low power and adjustable tone controls or switches and when using equalizers or room-correction devices. These situations may result in the system trying soon to overreach the amplifier's performance limits and may send distorted output signals to the speakers. Any damage caused under such circumstances is not covered by the AMR warranty and is easily avoided in the first place by consulting your authorised AMR retailer for advice regarding the choice of amplifier.

If you find that your system continuously lacks the necessary sound pressure level for your liking, despite using a high quality, high powered amplifier (> 120W RMS into 8 Ohm) please consider upgrading to one of AMR's OptiArray® configurations (see Appendix E – LS-77 in OptiArray configurations) and/or the use of AMR's own amplifiers using active crossover bi-amplification (see Appendix C – Biamplifying the LS-77). Be sure to consult your authorised AMR retailer for advise and a demonstration.

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Section 6 - LS- 77 Technical Features

The following section provides a brief explanation of the most salient technical features of the LS-77.

10" High Performance Low Frequency Driver - a unique design provides unparalleled low frequency extension in a compact speaker, combined with the midrange performance only available from large dome midrange drivers while minimising distortion and thermal compression.

5" Isoplanar Ribbon High Frequency Driver - AMR's use of a customised Isoplanar ribbon provides the smooth and clean treble associated with ribbon and electrostatic designs through a fusion of principles, yet with a design that matches and outperforms traditional dynamic high frequency drivers in terms of SPL capability and low distortion.

1" to 3/8" (25mm - 10mm) Solid Aluminum Enclosure - AMR's use of solid aluminium as enclosure material is driven by the simple fact that aluminium is eight to ten times as stiff as the materials conventionally used. Thus an enclosure using aluminium has much lower colorations than one using conventional materials.

TransmissionLine Port Low Frequency Loading - AMR's acoustic load combines the ability of transmissionline speakers to play very low notes loud and cleanly with the more compact dimension of traditional box designs by synthesising a new enclosure type from the best features of both.

OptiSlope® 10th Order Crossover - AMR's unique crossover minimises any interference between low and high frequency drivers to ensures an even on- and off-axis frequency response. The crossover is hardwired using air core copperfoil inductors; highest quality custom and german made film and tinfoil/film capacitors. It is then encapsulated in a viscoelastic compound to eliminate the influence of vibration on its operation.

OptiImage® - allows exceptional stereo imaging as a result of controlled directivity that reduces the amount of unwanted reflection and acoustic reverb in the listening room.

OptiArray® - allows the LS-77 to form larger arrays with fundamentally identical performance, coherence and imaging to the single LS-77 yet with the directivity and SPL capability to fill even the largest rooms with ease.

For a more detailed explanation of these and other features, please go to: www.amr-audio.co.uk

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Section 7 - Troubleshooting

Abbingdon Music Research

Figure 7.1 Troubleshooting Guide

Symptom	Possible cause	Solution
No sound	• incorrect audio cable connections	• connect the cables correctly
	• incorrect amplifier operation	• make sure that the input selector on the amplifier is set to the desired source
Sound with no bass and generally strange	• check speaker connectors are not connected with wrong polarity	• check polarity using the AMR test CD and correct if required
Sound is too bright or dull	• Incorrect placement of speaker	• Place speaker with high frequency driver upright and at / ear hight, pointing at the listening position
	• Incorrect adjustment of HF Level	• Adjust HF level as per Appendix A
Bass is too full or lean	• Incorrect placement of speaker	• Place speaker correctly as per Section 2
	• Incorrect use of port inserts	• Add (if too full bass) or remove (if too lean bass) port inserts as required
Other problems		• go to the Contents section and re-trace the procedure or contact your nearest AMR distributor/dealer

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Section 8.1 - Specifications

Figure 8.1 - Specifications Table

Sensitivity (2.83V/1m in room):	87dB
Long Term Power Handling (AES/RMS):	150W
Peak Program Power Handling :	600W
Impedance, nominal:	8Ohm
Impedance, minimal:	6Ohm
Frequency Response (in IEC Standard Room):	26Hz - 40kHz (+/-3dB)
Directivity Index (DI) 500-10KHz:	6dB (+/-3dB)
Low Frequency Driver:	243mm/10"Diameter, 100mm/4” Voice Coil
High Frequency Driver:	125mm/5" long isoplanar ribbon
Bass Enclosure Principle:	Transmission Line Reflex Port
Weight:	Speaker (each): 35 Kg / 77 lbs
	Shipped (pair): 116 Kg / 255 lbs
Dimensions (W x H x D) each:	250 x 490 x 300mm / 10 x 19 x 12"
Crossover:	AMR OptiSlope® design (60 dB/octave)

Information and specifications subject to change without notice.

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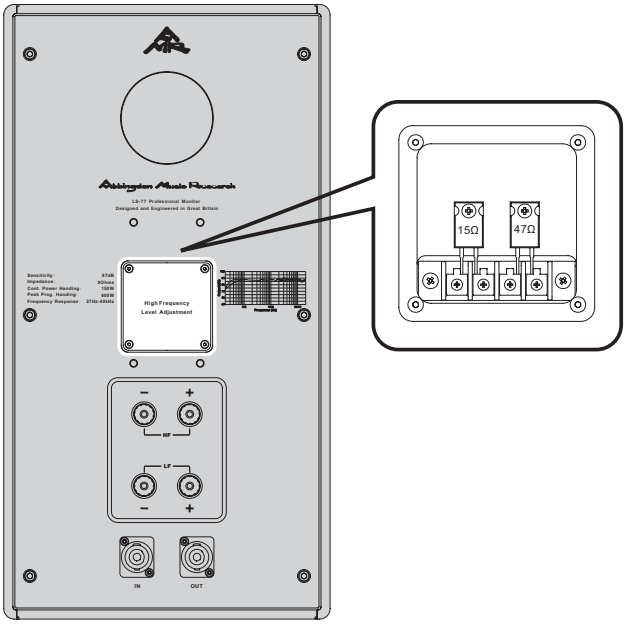
Appendix A - Adjusting tonal balance

If you feel that the tonal balance in the upper midrange and lower treble frequencies of the LS-77 is not correct for you, you may wish to change the resistor combination fitted under the cover labelled “High Frequency Level Adjustment”. Some of the required adjustment may be due to the differences in listening distance while others may be a result of differences in taste and furnishings.



Remove this cover after removing the machine screws that hold the cover in place using the 2mm metric hex key (Allen Key) which is provided with your speakers (or equivalent replacement if lost). Under the cover you will in stock condition find two resistors one marked 15Ù and one marked 47R. You will also find a pair of optional resistors included per speaker, one marked 100 and the other marked 220.

Respectively the resistor marked 100 will be referred to below as 10R, the 15Ù as 15R and the one marked 220 as 22R. Using different combinations allows an adjustment of the upper midrange and lower treble frequencies by +/-3dB in steps of around 1.5dB.

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Below and overleaf are listed our recommendations for different listening distances and placements. However, there is not per se any specific value that is right or wrong. Please use your own preference, discernment and hearing as guide. It is right when it sounds right.

To increase the upper midrange and lower treble frequencies compared to whatever you have currently installed use a combination marked with a greater dB value; to decrease the upper midrange and lower treble frequencies use a combination marked with a lower dB value. Should you, for any reason find the existing adjustment range insufficient please contact us for further options.

Listening Distance around 1m (nearfield listening and nearfield monitoring)

HF Level	R1	R2	Placement Suggestions
+1.5dB	15 R	10 R	Placement of speaker on a bookshelf or very close to walls
0 dB	15 R	22 R	Placement within around 1m of rear wall
- 1.5dB	**15 R**	**47 R**	**Placement of speaker 2m or more from rear wall (factory fitted)**
- 3 dB	15 R	not fitted	not recommended

Listening Distance around 3m (normal listening room placement and midfield monitoring)

HF Level	R1	R2	Placement Suggestions
+3 dB	15 R	10 R	not recommended
+1.5dB	15 R	22 R	Placement of speaker on a bookshelf or very close to walls
0 dB	**15 R**	**47 R**	**Placement within around 1m of rear wall (factory fitted)**
- 1.5dB	15 R	not fitted	Placement of speaker 2m or more from rear wall

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Listening Distance around 5m (farfield listening or monitoring)

HF Level	R1	R2	Placement
+3 dB	15 R	22 R	not recommended
+1.5dB	**15 R**	**47 R**	**Placement of speaker on a bookshelf or very close to walls (factory fit.)**
0 dB	15 R	not fitted	Placement within around 1m of rear wall
- 1.5dB	not Fitted	22 R	Placement of speaker 2m or more from rear wall

If you feel that the tonal balance in the low frequencies of the LS-77 is not correct for you or your room, you may need to change the positioning of the LS-77. Some of the required adjustment may be due to the differences in placement or the room's low frequency behaviour, while others may be a result of differences in taste and furnishings.

If the low frequencies are percieved as too prominent you may wish to fit the large cell foam inserts to either reduce the output of the port or you can completely seal the port using the insert made from dense foam. Typically, the closer you place your speaker to the wall, the more the port output needs to be attenuated.

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Appendix B - AASR

The Abbingdon Acoustic Setup Regime (AASR) is a process of optimising the Speaker/room/listener placement interactively, repeatable and is rooted in decades worth of practice. AASR takes account of the simple fact that no rigid mathematical principle, no simulation software and no measurement system currently available correlates reliably with subjectively perceived "good sound". AASR is concrete and reliable science, not some form of voodoo, though the process is very involved and some of it will seem somewhat unconventional. Using AASR provides an imaging and sound-staging that is exceptional. Non of the mathematical based procedures even takes these two matters into account.

The most basic requirement for AASR is to establish the Zone Of Least Interaction (ZOLI) with walls. This area is found in every listening room and is usually two to five feet long (60-150cm). It is the region most likely to be free of the listening room's most severe acoustical interaction. The first stages of determining the zone will produce a largish area, but at this point the rough dimensions must be regarded only as a basic starting point.

With the aid of a friend who does not mind feeling a little foolish, place yourself in the target listening position while your assistant speaks in a moderately loud voice at constant level, projecting into the room. Alternatively, use your own voice and walk in similar patterns listen to how your voice interacts with the room. Give it a few tries and listening very hard you will know what it is about. When you or your assistant comes to the boundary of the ZOLI (zone of least interaction) nearest to the side or rear wall the voice will become more prominent in lower frequencies and will seem to have more energy. When exiting the ZOLI towards the middle between wall again a distinct change in vocal tonality will be heard.

The first step is used to determine the zone relative to the back wall, so the person speaking should start at the back wall, in front of the listening position, walking toward the listening position while speaking. As the speaker approaches the listening position, the voice will appear to 'free up' as it is relieved of the low frequency energy imparted by the closeness to the rear wall. In other words, you are listening for the point in the room where the rear wall stops to reinforce bass. When this point is reached, mark the floor with a piece of masking-tape or similar.

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With the person speaking and continuing to walk toward the listening position while talking at the same level, listen for the next change in the voice's tonal quality. This will be the first interaction of the opposite wall and should sound like a loss of focus that seems to resonate because of the side and rear wall reflections. Again, mark the position on the floor when the artifact first appeared with tape. You now have the front and back borders of the ZOLI.

Using the same procedures, but with the person speaking starting at the side walls and walking across the room in front of the listening position, you can now determine the left and right boundaries of the ZOLI. Again, as the person speaking walks away from the side walls, you should hear the voice freed up from the bass reinforcement provided by the side walls, eventually reaching a point where the opposite wall begins to interact with the voice. Repeat this for the left and right side walls, again marking the borders with tape.

Now if you do this alone, you may find that the borders are marked fairly different for the various walls. Simply using these borders would result in an asymmetrical arrangement of the speakers. So take some measurements and average all the different borders you came up with. Then re-arrange the tape to reflect the symmetrical average of your various positions. After performing these procedures you will have two ZOLI's, like the squares drawn around the speakers in the illustration.

To accommodate the AMR LS-77, simply adhere to the basic angles of around 60 degree and to the 1:1.1 to 1:1.25 ratio of listener distance from the speakers vs. Speaker-to-Speaker distance for the triangle formed by listener and speakers. The triangle in the drawing overleaf is a fine starting point to help you locate your listening seat prior to utilising the further steps of the AASR.

It's time now, to place your speakers and stands in these zones. For the time being, leave off any spikes or feet because you will have to move the speakers in the following fine tuning process. Sliding the stands with smooth undersides is a lot easier than dealing with spiked stands or enclosures.

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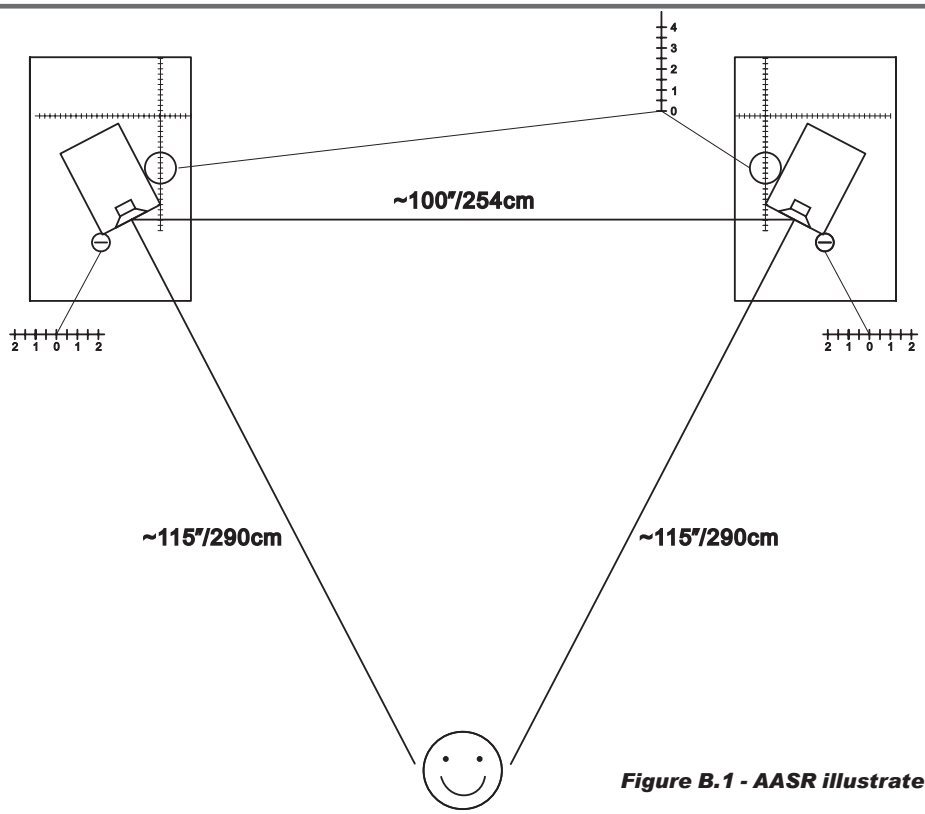

Figure B.1 - AASR illustrated

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If your floor is not carpeted (which is a bad idea acoustically) you may want to put something between the speaker stand and floor that will allow you to slide the speakers more easily, like a cloth or mat with a smooth underside. If your stands' lower surface is not smooth and you have a carpeted floor you may wish to place the stand on a suitable piece of MDF or wood with smooth surfaces to making sliding the speakers around easier.

Position each speaker in the center of each ZOLI, pointing directly at the listening position. This may seem like an extreme amount of toe-in, but it is in most cases the best initial point. You should just be able to see either the inside walls or outside walls of the speakers.

Next, you need to 'calibrate' the floor with tape as shown in the illustration to help you shift the speaker repeatably in small increments. Using l/2" or one centimeter markings will be fine. The strips marked 0-1-0 (parallel to the back wall) should be located close enough to the speaker stands front-most corner so as to help you to gauge both left-to-right movements and to adjust the amount of toe-in or toe-out. Again, you should enlist the help of an assistant for be next phase of the AASR, as it is difficult to do it alone.

Using a full-range, well-balanced recording played at a moderate level first ensure the tonal balance of the speaker has been correctly adjusted. This is easiest judged using a recording featuring female voice and piano. Do not consider the bass output at this time, check only the midrange tonal balance for the right degree of openness and natural tone, without sounding neither dark or bright.

Next make notes regarding the sound quality as your assistant moves the speakers first forward/backward and then left/right. By using the tape rulers as accurate indication of the position you or your assistant can move the speaker as far as needed to find the point where further movement into this particular direction does not bring further improvements and still return to the best position. Listen for the best tonal balance and the ability of the system to portray dynamics as well as the beginnings of good imaging. Conventional wisdom applies here: if the system sounds bass shy, move the speakers back, bass heavy, move them forward.

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With the most important of the rough adjustment being the front-to-back distance, mark the speakers' positions on the floor where the front edge of the speaker would be with tape, so you can always return to this position. The tape should extend beyond the ends of the baffle, because you will be moving the speaker relative to the main rough position. Using a solo piano recording, move the speaker with relation to side wall in small increments, while you listen for the 'attack', the dynamic or transient accuracy and how it affects overall harmonic integrity.

Now you can fine-tune the toe-in to have the image "snap" into focus, taking care not to alter the front-to-back or side-to-side relationships. The AMR Test CD contains in phase and out of phase mono pink noise tracks that can be used to optimise both the Focus (precisely defined instrument images) and depth of the soundscape. Toe-in adjustments means only the rotating of the speaker on its centered position. Change the toe-in until the image "focuses" right in front of the speakers with a good sense of "depth" remaining. You should cross-check using an orchestral stereo-recording (preferably with minimal miking and not multi-tracked).

Make absolutely sure that the positioning of the speakers is truly symmetric and the degree of toe-in is identical. Now mark the positions again on the tape, refit the spikes or other feet to the stands and return the speakers and stands to the exact locations indicated by the tape. If you feel the bass is still too heavy or slow, after full AASR optimisation, please experiment with adjusting the bass output using the supplied port inserts.

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Appendix C – Biamping the LS-77

AMR's LS-77 speakers are designed from the inception with the option to be bi-ampliffied. This means that dedicated amplifiers are used to drive the low frequency driver and high frequency driver separately. This provides improved clarity and resolution, as the amplifier driving the high frequency driver does not have to deliver the large currents drawn by the woofer and hence will produce less distortion.

You must use two IDENTICAL stereo amplifiers to biamplify the LS-77 (AMR's AM-77 has a build-in mode designed for optimum operation to biamplify any speakers, including the LS-77). You must also use two IDENTICAL pairs of conventional speaker cables or a special pair of "dual headed" Speakon connector cables available from your AMR retailer.

Please refer to section 3.1 Setup - Connecting the loudspeakers for detailed information and tips on the different available connectors.

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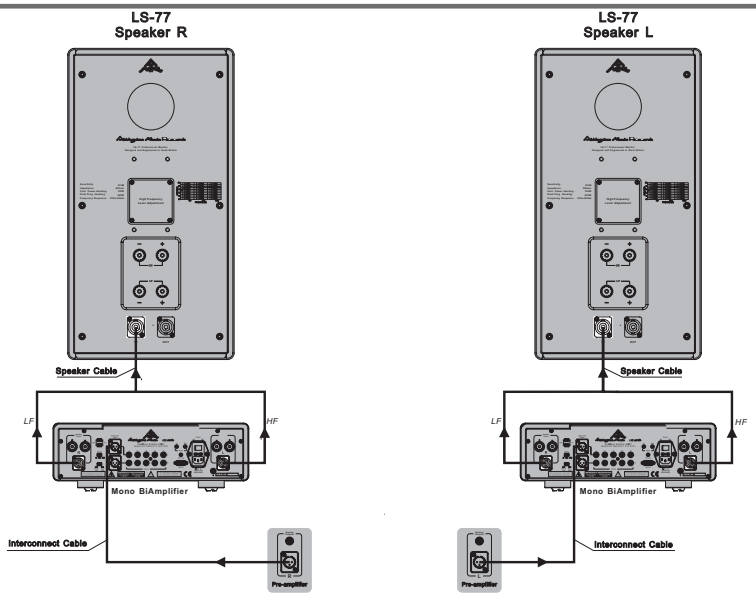

Figure C.1 - System connection using Speakon connector equipped speaker cables (AMR AM-77)

i. Connect the respective Speakon connectors of the speaker cables to the LS-77 (left & right).

ii. Connect the respective dual headed end of the speaker with its Speakon connectors of the speaker cables to your amplifier, the connector marked HF connects to the left channel, the connector marked LF connects to the right channel.

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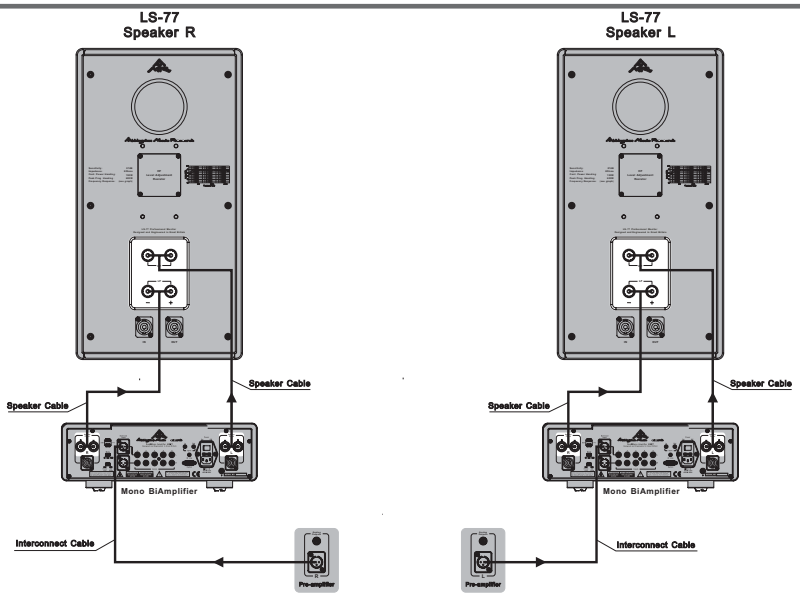

Figure C.2 - System connection using banana plug/spade connector equipped speaker cables

i. Connect the respective spade/banana connector or bare wire of the speaker cables to the LS-77, use one cable pair for the pair of binding posts labelled "HF" and the other for the binding posts labelled "LF". Observe polarity/marked colours of binding posts and cables.

ii. Connect the respective spade/banana connector or bare wire of the speaker cables to your amplifier in a like manner.

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Appendix D – The AMR Active System

For maximum performance AMR's active system allows AMR's LS-77 speakers to be driven in active mode by AMR's amplifiers. Separating the frequency ranges before the amplifiers avoids the destructive intermodulation between the low and high frequency signals being passed through the same amplifier and increases the available power and SPL.

AMR uses custom designed high quality passive filters instead of large numbers of Op-Amp's and other active components, as a result avoiding many shortfalls (e.g. signal distortion) commonly associated with other active systems. Hence, AMR's active system combines all the benefits of fully active operation with a much simplified handling and physical setup.

D.1 - The AM-77 Control Center Edition (CCE)

The corner stone of AMR's active system is the AM-77 CCE Amplifier. The AM-77 CCE acts as a (i) preamplifier, (ii) active crossover and (iii) high frequency amplifier. Thus it combines three separate devices into one without loss of performance but with the added benefit of eliminating several interconnects.

The amplifier boards are optimised for high frequency reproduction including the use of non-magnetic Silver Foil & Mica dielectric coupling capacitors, which have been found most ideal for detailed, resolved and non-fatiguing high frequency reproduction. Hence the high frequency outputs from the active crossover are routed directly to the internal power amplifier. The low frequency outputs of the active crossover are sent to additional AM-77s configured as power amplifiers via the "Option" connector.

All control functions such as Input selection, volume control etc. are performed ONLY by the AM-77 CCE, in effect the AM-77 CCE acts as the preamplifier with additional active crossover function and high frequency amplification built-in.

Two or even four AM-77 CCE can in turn be operated as monoblock amplifiers with control functions to allow very large systems to be assembled around AMR's core components. Any AM-77 can be converted into a CCE Amplifier and visa versa by your AMR retailer at notional cost.

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D.2 - Setting up the AMR Active System

Loosely place the speakers and connect the bi-amplification speaker cable supplied to each speaker, using the connector marked "LS-77".

Speakon connectors are first inserted and then rotated clockwise until they lock in place. To remove Speakon connectors you need to pull the metal catch backwards and rotate the connector counter-clockwise to unlock the connector so it can be pulled out. Then route the speaker cables to the location at which the amplifiers will be placed.

Place the amplifiers considering the amount of reach between the two separate Speakon connectors on the amplifier side of the bi-amplification speaker cable.

Place the AM-77 CCE as you would normally place your preamplifier or AM-77 amplifier. Confirm that the AM-77 CCE has been configured as Stereo Pre-Main Amplifier (see page 39 of AM-77 Manual).

Please refer to the connection diagrams overleaf for detailed illustration and note the scenarios presented.

Line Level Connection

Scenario 1:
AM-77 CCE x 1

AM-77 x 1 (the AM-77 must be in Stereo Power Amplifier Mode)

(see page 44 of AM-77 Manual)

Option cable Left channel RCA (Blue)	→	AM-77 Input 1's Left Channel
Option cable Right channel RCA (Red)	→	AM-77 Input 1's Right Channel

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Scenario 2:
AM-77 CCE x 1

AM-77 x 2 (each AM-77 must be in Monoblock Power Amplifier Mode)

(see page 46 of AM-77 Manual).

Option cable Left channel RCA (Blue)	→	Left AM-77 Input 1 Left Channel
Option cable Right channel RCA (Red)	→	Right AM-77 Input 1 Left Channel

Attach the power cables to the amplifiers, however do not connect the power cables to the mains yet nor should the amplifiers be switched on.

Route the mains cables so that they run cleanly and without sharp bends towards the power extension strip and then attach the mains cables.

Speaker Connection

Scenario 1:
AM-77 CCE x 1

AM-77 x 1 (the AM-77 must be in Stereo Power Amplifier Mode)

Left speaker cable connector marked "HF/CCE"	→	AM-77 CCE 's Left Channel Speakon socket
Right speaker cable connector marked "HF/CCE"	→	AM-77 CCE 's Right Channel Speakon socket
Left speaker cable connector marked “LF/AM”	→	AM-77's Left channel Speakon socket
Right speaker cable connector marked “LF/AM”	→	AM-77's Right channel Speakon socket

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Scenario 2:
AM-77 CCE x 2 (each AM-77 CCE must be in Monoblock mode)

AM-77 x 2 (each AM-77 must be in Monoblock Mode)

Left speaker cable connector marked "CCE"	→	AM-77 CCE 's Left Channel Speakon socket
Right speaker cable connector marked "CCE"	→	AM-77 CCE 's Right Channel Speakon socket
Left speaker cable connector marked “AM-77”	→	Left AM-77's Speakon socket
Right speaker cable connector marked “AM-77”	→	Right AM-77's Speakon socket

Now attach the input connections from your CD-Source ONLY to the AM-77 CCE.

Connect the power cables of all amplifiers and the CD-Player to the power extension strip.

ALL amplifiers and sources must be operated from the same power extension. Failure to do so will lead to earth loops which may cause significant audible hum.

Switch on the CD-Source, followed by the AM-77 CCE and finally the AM-77 Power Amplifier and/or AM-77 Monoblock Power Amplifier.

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D.3 - Testing and Troubleshooting the AMR Active System

Please use the AMR Test & Burn In CD's channel identification track to verify that your system's channel assignment is correct.

If the low frequency channels have been mixed up the channel identification sequence will have the high frequencies coming from one channel with the low frequencies from the other. In this case please switch around the interconnects or speaker cables (one OR the other, not both) for the power amplifier. Please power down the all amplifier(s) before breaking and re-making connections.

If the sound lacks severely in high or low frequencies and either high or low frequency driver remain silent, please check all connections between speaker, amplifiers and CCE again and compare to these notes and the included drawings.

Play some music with a large amount of high frequency and low frequency content. If the high and low frequencies appear rolled off, please check that the speaker cable connectors labeled CCE are attached to the AM-77 CCE and that the speaker cable connectors labeled AM-77 are attached to the AM-77(s) configured as power amplifier(s).

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D.4 - AMR Active System Configuration Diagram

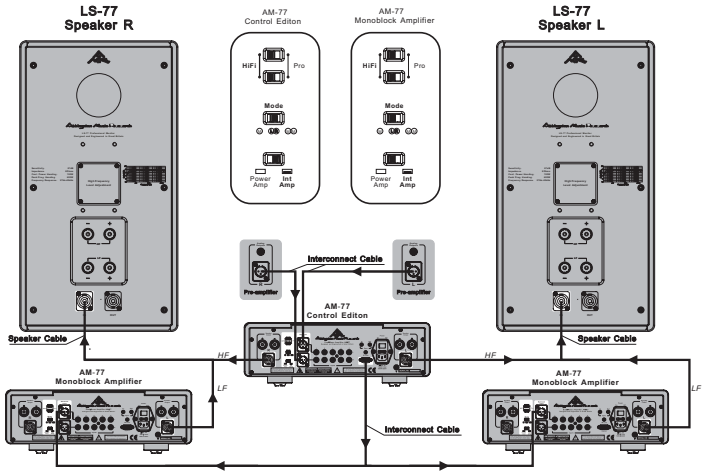

Figure D.1 - System connection using Speakon connector equipped speaker cables

i. Connect the respective Speakon connectors of the speaker cables to the LS-77 (left & right).

ii. Connect the respective dual headed end of the speaker with its Speakon connectors of the speaker cables to your amplifiers as shown above.

iii. The connector marked HF connects to the respective channel of the AM-77 Control Center, the connector marked LF connects to respective channel's monoblock Amplifier

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Appendix E – LS-77 OptiArray

E.1 Introducing AMR's OptiArray® scalable acoustic system

Above and beyond the role of an exceptional quality midfield monitor, the AMR LS-77 is designed to form the main element of the AMR OptiArray® scalable, modular loudspeaker system. The OptiArray® system takes account of several basic acoustic facts.

i. The larger a room the louder must a speaker play for a given sound level at the listening position.

ii The larger a room the more and to lower frequencies must the speaker directionality increase to maintain the same ratio between direct sound (that of the recording - wanted) and indirect sound (reverbrations in the room, - unwanted).

Large listening spaces invariably require more acoustic power applied to the air volume in the room to excite the same amount of pressure change (a bottle of beer will nearly fill a pint glass, however in a large bucket it will barely moisten the bottom), this much is quite obvious, so the need for more output from the speaker as rooms get larger is simple and intuitive.

However, large listening spaces are invariably also less well damped, in an acoustical sense, than small ones. This and the much longer dimensions with the thus increased delay between reflections lead to much longer reverb times in the room. The room reverbrant field (that is sound radiated and re-radiated by the walls, floor and ceiling) will interfere most crucially with the percieved space of the recording and will secondarily often change the tonality of the sound as well.

For a striking example compare the sound of a portable radio in an equal size empty room and one well furnished. In the empty room the sound will be clattery, echoy, phasey and indistinct as well as subjectively too bright. In a normally furnished room with carpeted floor the sound will be much more natural. Ideally we wish to keep the unavoidable contribution of the room sound over the direct sound below the threshold where the room influenced sound overwhelms the direct sound.

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While one can (and should) add acoustical treatment to large spaces, these are only effective to a certain degree and not at really low frequencies. To effectively damp the reflection of a 350Hz tone the layer of damping material applied to the wall would have to be at least 25cm thick! Instead of damping the reverbrations, using speakers that exhibit a significant increase in directivity at all frequencies over traditional systems attains an equal or greater improvement.

Thus the larger the room the more closely must the speaker control directivity to retain the same ratio between the actual recorded sound and that produced by the room reverberation at any given frequency.

The AMR OptiArray® system provides a speaker system that can be expanded from a single pair, which is appropriate in terms of directivity and acoustic output for rooms up to around $35m^2$ (with normal ceiling height), via a dual pair system that covers up to $70m^2$ and scales through intermediate configurations of four and eight pairs of speakers finally up to sixteen pairs in a 'focused dual line array' configuration, used to cover cavernous listening spaces of up to $480m^2$*.

Due to the carefully considered directional properties of the single LS-77 and its seamless integration into larger arrays. Each larger size array extends the tight (40^o) vertical and wide but controlled (120^o) horizontal radiation angle to lower frequencies, counteracting the room's tendency to have increasing reverb times at a given low frequency with increasing room size.

A 2m tall vertical array of eight LS-77s manages to control the sound radiation down to 80Hz, whereas a single LS-77 provides controlled directivity only down to 360Hz (which is still much lower a frequency than most high fidelity speakers manage and entirely appropriate for moderate sized rooms).

*Note - A room of $480m^2$ is a small concert hall around 28m long and 17m wide!

The modular nature of the LS-77 OptiArray® system allows AMR's setup to be scaled to almost any size listening room. As the numbers of speaker pairs are increased in the Opti-Array configuration, the power handling and SPL capability increase ever more dramatically over a single pair of LS-77s.

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AMR recommends the following OptiArray Setups:

Room Size	**≤35m²**	**25m²–70m²**	**50m²-140m²**	**100m²-280m²**	**200m²-480m²**
System	***Alpha***	***Epsilon***	***Iota***	***Omicron***	***Upsilon***
	(passive)	*(passive)*	*(passive)*	*(passive)*	*(passive)*
AM-77	1	1	2	4	8
LS-77 (pairs)	1	2*	4*	8*	16*
Power	360W	360W	720W	1440W	2880W
SPL (3m)	109dB	112dB	118dB	124dB	130dB

System	***Beta***	***Zeta***	***Kappa***	***Sigma***	***Omega***
	(active)	*(active)*	*(active)*	*(active)*	*(active)*
CCE	1	1	1	2	4
AM-77	1	1	2	4	8
LS-77 (pairs)	1	2*	4*	8*	16*
Power	560W	560W	1120W	2240W	4480W
SPL (3m)	113dB	116dB	122dB	128dB	134dB

*: OptiArray configuration

The Alpha system using a single pair of LS-77s with a total system power capacity of 360W, can sustain 109db SPL at 3m listening distance for the complete system and is thus appropriate for moderate city appartments and condominiums. From this AMR's OptiArray® configurations extend to the awesome Omega system providing a configuration suited to any size dwelling and listening room. This Omega system consists of 16 pairs of LS-77s in OptiArray® configuration, with a total system power capacity of over 4480W. The Omega system can sustain 134dB SPL at 3m listening distance for the complete system, which is more than many Concert Sound Reinforcement Systems.

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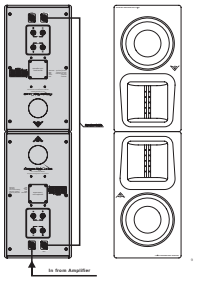
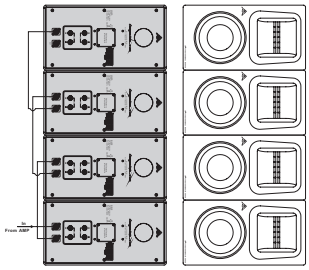
AMR offers preconfigured wiring harnesses and where neccesary mounting and safety hardware for all larger OptiArray® systems. However, due to the complexity of setting up the larger OptiArray® systems we recommend to arrange the installation with your AMR retailer.

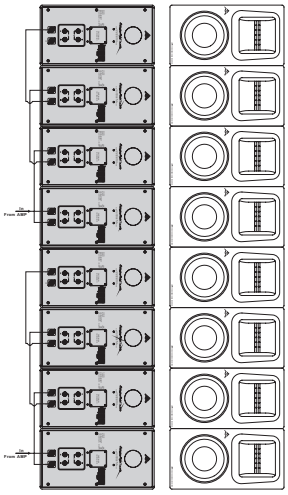
The following pages show the wiring diagrams and setup options for some of the recommend speaker arrangements (the Epsilon/Zeta systems, the Iota/Kappa systems and finally the Omicron/Sigma systems). Available page space prohibits the illustration of the largest configurations.

Overleaf you will find a large size representation of the Epsilon/Zeta setup illustrating in detail the arrangemnt, wiring and other details...

Epsilon/Zeta ***Iota/Zappa*** ***Omicron/Sigma***







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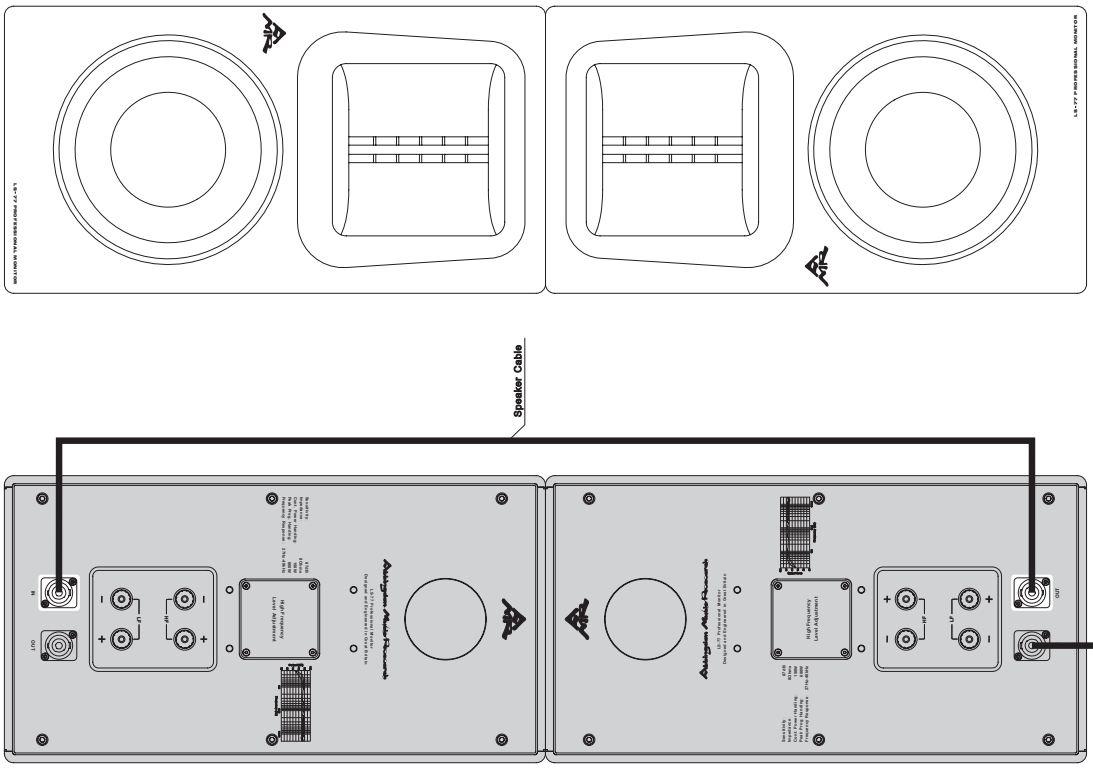

Epsilon/Zeta
System wiring

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Appendix G - Acoustics Background Abbingdon Music Research

G.1 Acoustics

When we talk about making a room "sound right", we are probably dealing with room acoustics. As a science acoustics has been around for about a hundred years. Until then good acoustics happened by experiment, by experience, or simply by accident.

Today we know a lot about the parameters that influence the "sound" of a room. Talking about the listening room we know that basically this room should act as neutral as possible. But this is not always the case. Lets just take a short look on some of the issues that one must be aware of.

G.2 Good acoustics

Here is a list of important parameters concerning good acoustics.

- Proper reverberation time
- Good sound distribution
- Adequate sound pressure level
- Low background noise level
- No echo (flutter echo)

Now lets have a look on these headlines that will be adequate for the most purposes concerning sound production.

G.3 Reverberation time

The reverberation time is defined by the time it takes a sound to attenuate 60 dB after the source is stopped. In real life we can experience reverb times from approximately 0sec. (outdoors or in anechoic chambers) to something like 10-12 sec. In special reverb chambers the time may exceed 20 sec. Listening rooms normally should have a reverb time around 0.2 - 0.3 sec.

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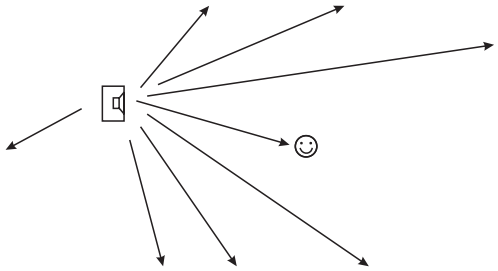
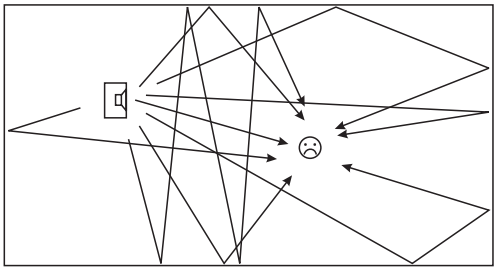
Why do we have reverberation? The speed of the propagating sound wave is very slow - at least compared to light: approx. 1130ft. or 340m per sec.

If there are no reflecting surfaces between the sound source and our ears, only the direct sound is heard and there is no reverberation. If there is a single reflecting surface we may hear the reflected sound in one way or another, but there is still no reverberation. If the sound is generated in a room, there are a whole lot of reflections. Each of these travels different paths with different distances on the way to the receiver. Each time the sound hits a surface it may loose some energy if the surface is absorbing.



One sound source and one listener in an open area. Only sound coming direct from the source is heard.



One sound source and listener in a room. The sound impulse is reflected via many surfaces. All the reflections are melting together and heard as additional reverberation.

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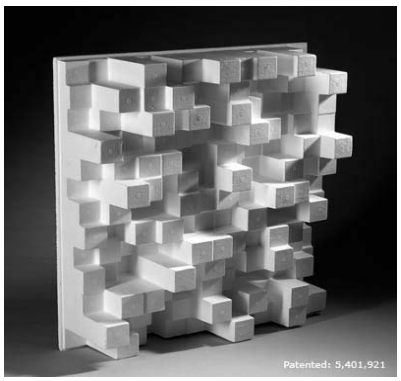
G.4 Diffusers

A diffuser provides diffuse reflection of the sound radiated against it. It can be a very useful solution in cases where reflections are disturbing the sound image and it is not advisory to add further absorption. So in order to reduce flutter echoes, comb filtering etc., special elements can be placed on the "disturbing" surface. These elements must have dimensions comparable to the frequencies at which diffusion is wanted.

Often bookshelves stocked with books of irregular sizes and/or music collections (LP's or CD's) can act as non-ideal diffuser, if dedicated diffuser devices cannot be used.



Schroeder type Diffusor

G.4.1 Absorption or Diffusion ?

A special technique developed by Manfred Schroeder is very capable in making a smooth and controlled diffusion. These diffusers normally referred to as "Schroeder Diffusers" can be found as readily made modules.

G.4.2 Absorbers

All materials in the room act acoustically even if they are not specially designed acoustical materials. In domestic situations we have generally two types of absorbers.

G.4.2.1 Membrane absorbers

This kind of absorber includes wooden floors, windows, doors, etc. This absorber provides absorption in the low end of the frequency range. The efficiency is normally not very high, but under normal conditions large areas are included in the basic room construction. Special designed membrane absorbers can be very effective. Placing a wood laminate floor on suitable acoustic backing can provide one such absorber.

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G.4.2.2 Porous absorbers

These absorbers include mineral wool, foam, carpets, curtains, and so on. They can be very effective, but the thickness of the material has to be taken into account. Thin layers will only absorb the highest frequencies. To absorb a given frequency (and all frequencies above) the thickness of the absorber must be the quarter of the wavelength of that frequency. Alternatively the front of the material must be placed at a distance of one quarter of the wavelength from the nearest surface.

Sofas and armchairs form very large and effective absorbers, especially if additionally being filled up in their hollow cavities, placing acoustic foam or felt behind wall hanging rugs can dramatically improve their absorbtion without adding to the visual impact. Placing heavy underlay felt underneath carpets can improve their absorption. Special absorbing foam such as the melamin based BASF BasoTect® foam that is also used inside your LS-77 can be surfaced with thin cloth or even silk paintings to give good looking yet highly effective absorbers.

G.5 Standing Waves

Standing waves exist in all kind of rooms. The shape of the room, the dimensions of the room, and the relationship between the dimensions of the room, allare important parameters that will determine the frequencies around which the phenomenon exists as well as the distribution of these standing waves. But how do they occur?

Imagine a sound source.

When the sound is emitted the sound wave will propagate in all directions if no obstacles are in sight. This will of course happen with the speed of sound. Now, if the sound source is placed inside a room, the sound wave will hit the boundaries of the room. If the boundaries consist of acoustically hard (reflective) surfaces, the sound is reflected. If the angle of incidence is 90º the sound will be reflected right back where it came from.

Under certain circumstances the sound wave will meet itself again. For instance if the sound is reflected between two parallel walls. This becomes a problem, when the sound wave not only meets itself, but when it meets itself in phase. And this will happen when the distance between the walls is half a wavelength of the radiated sound

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wave. Or one whole wavelength - or 1½, 2, 2½ and so on. This phenomenon is called standing waves. Actually the sound wave is not standing. But it is experienced like that because the sound pressure maxima and minima are positioned in fixed places in the room.

G 6 Room modes

These special frequencies are also called room modes. Standing waves between parallel walls are called axial modes. Other modes exist. For instance tangential and radial modes. Normally the axial modes are the strongest.

The standing waves are characterized by having a maximum sound pressure at the boundaries of the room. Depending on the frequency there are one or more dips across the room. In a box shaped room the frequencies can be calculated as follows:

$$f = \frac{c}{2}\sqrt{\left(\frac{n_l}{l}\right) + \left(\frac{n_b}{w}\right) + \left(\frac{n_h}{h}\right)}$$

Where:

f = frequency in Hz; c = speed of sound (approx. 340 m/s or 1130 ft/s); l = length of the room;

b = width of the room; h = height of the room; n = integer from 0 and up

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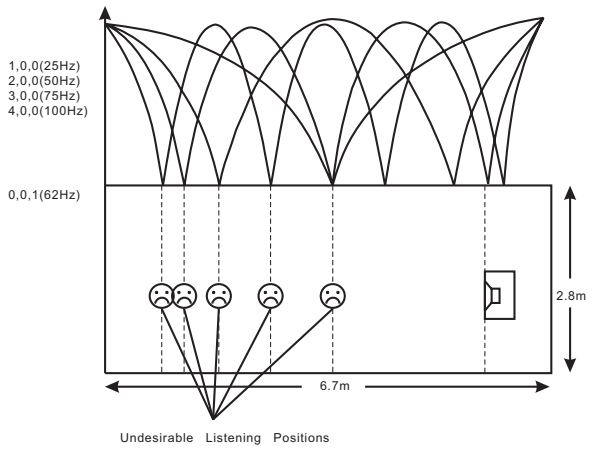
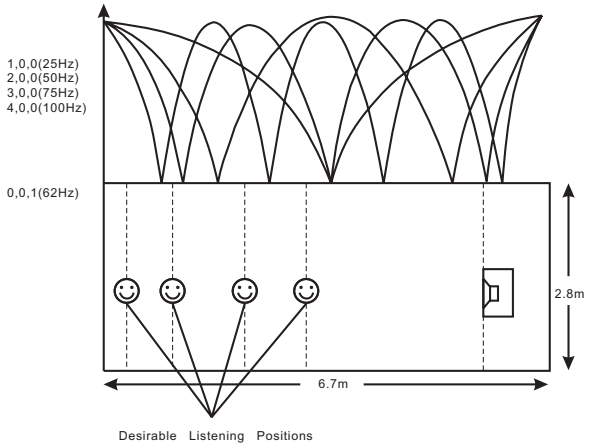


How does the standing waves influence the sound field? - The curve expresses the area of the room where the actual frequency is audible. At the minima the frequency is represented at a much lower level (sometimes -40 dB compared to the maximum). If the room has the same dimensions as length, width, and even height it is very problematic to obtain an even sound distribution.



How to prohibit standing waves - Parallel walls in the room should be prevented if possible. Then the strongest modes are suppressed. This obviously requires purpose built rooms. When placing the speakers it is important that as few modes as possible are excited. This is why the speakers should not be placed in a maximum of a standing wave, nor should the listener be located in a maximum or minimum of a standing wave.

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